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Intrinsic incentives in household waste recycling: The case of Italy in the year 1998

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ABSTRACT

This paper studies the relationship between environmental concern and household separate waste collection, controlling for social capital, in Italy in the year 1998 when policy makers started to raise awareness of the importance of waste prevention, disposal and recycling. At the time, the public's sensitivity and attitude to waste issues were mainly influenced by their own lifestyles. We consider five separate waste collections, namely paper, plastic, glass, aluminium and food waste, to be taken to the relevant roadside containers. It focuses on three types of environmental concerns, classified as egoistic, altruistic and biospheric, and identifies five measures of general environmental issues able to match the different types of concerns considered. It also controls for three types of social relations: bonding, bridging and linking social capital. We use the dataset from the Multipurpose Household Survey, conducted by the Italian National Institute of Statistics (ISTAT), and five probit models to shape the number of separate waste collections. The results show that greater concern for waste production and disposal, pollution, climate change, resource depletion and alteration of environmental heritage is related to a higher likelihood of doing household waste recycling. Nonetheless, for the highest number of separate waste collections, the magnitude of the marginal effect of environmental concern variables decreases, showing the relevance of marginal costs in recycling behaviour. Finally, bridging social capital is the only social capital positively correlated with all five separate waste collections.

1. Introduction

Waste management has received growing attention in recent decades from both academics and policy makers, poor waste management being widely acknowledged as a source of economic costs, as well as health and environmental risks (Kinnaman, 2006; Van den Bergh, 2008; Agovino et al., 2018a; Agovino et al., 2019). An important branch of solid waste management is household waste recycling. While recycling is a time-consuming activity, requiring individual effort in sorting household waste and transporting it to recycling bins, it has positive long-term social and environmental effects, such as conservation of resources and a reduction in general waste management costs (Nordlund and Garvill, 2002).

Household waste recycling has been widely investigated within the social sciences, especially economics, sociology and psychology. Some economists have focused on unit pricing systems, monetary incentives and recycling programmes as drivers of household recycling effort. Others have looked into warm glow and self-image[1](Hong et al., 1993; Fullerton and Kinnaman, 1996; Jenkins et al., 2003; Dijkgraaf and Gradus, 2004; Berglund, 2006; Halvorsen, 2008; Hage et al., 2009; Abbott et al., 2013; Czaikowski et al., 2014; Bucciol et al., 2015). Sociologists have studied the role of personal norms activated through social interactions and social pressure (Hopper and McCarl Nielsen 1991; Thogersen, 1996; Sidique et al., 2010). Finally, psychologists have investigated

[1] The reference points for warm glow are Deci (1971) in the psychological literature and Andreoni (1990) from the economics literature. According to Deci (1971), warm-glow giving means that an individual is motivated to perform an activity when he/she receives no apparent reward except the activity itself. In the model of Andreoni (1990), warm glow means that the individual's utility is not just a function of the consumption of the private and public goods but also of the individual's contribution to the public good itself. This is commonly referred to as the "warm-glow" effect and describes a form of impure altruism (Daube and Ulph, 2016).

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environmental concerns (Vining and Ebreo, 1990; Schultz et al., 1995; Barr et al., 2001; Chu and Chiu, 2003; Barr, 2007).

This stream of interdisciplinary research may be summarised in terms of predictors of household waste recycling into three groups (Hornik et al., 1995): (i) demographic characteristics (gender, age, education, income, homeowners and others); (ii) extrinsic incentives (unit pricing system and monetary incentives); (iii) intrinsic incentives (social norms, warm-glow, social interactions and environmental concerns).

Within the intrinsic incentives group, several papers have analysed the link between environmental concerns and recycling behaviour (Miafodzyeva and Brandt, 2013), while some studies have focused on social capital and pro-environmental behaviour (Agovino et al., 2018b). The former studies, which have been considered highly heterogeneous regarding the conceptual definition of environmental concerns and how to measure them (Best and Mayerl, 2013), show mixed results (Schultz et al., 1995; Tadesse, 2009). They present little evidence to justify the classification of environmental concerns into egoistic, altruistic and biospheric (Schultz et al., 2005), and no evidence linking the various types of environmental concern and the number of separation waste collections. The latter studies, in which social capital is a multidimensional concept (Pretty, 2003), exhibit clearer findings with reference to the link with recycling behaviour (Jin, 2013), but with no evidence relating to the number of waste separation collections.

The aim of the present study was to analyse the relationship between egoistic, altruistic and biospheric environmental concerns and the number of waste separation collections in Italy in the late 1990s, controlling for social capital as robustness analysis.

Our paper contributes to the literature on household waste recycling in several ways. First, we focus on the recycling efforts of Italian households by measuring the number of separate waste collections made by householders with reference to different materials to be taken to the relevant bins placed along the street, and not necessarily close to their homes. Second, in line with previous studies, we consider three types of environmental concerns, namely egoistic, altruistic and biospheric, and we set up economic empirical hypotheses linking environmental concerns considered with the number of separate waste collections at household level. Third, following the environmental literature, we identify five measures of general environmental issues able to match with egoistic, altruistic and biospheric environmental concerns. Fourth, we perform an econometric analysis of the correlation between individuals' environmental concerns and their propensity to separate waste to be recycled, controlling for demographic and socio-economic characteristics and taking into account social capital variables to perform a robustness analysis. To the best of our knowledge, the empirical assessment of the relationship between general environmental concerns and household waste recycling has been never performed in Italy.

To study the link between individuals' environmental concerns and their effort to sort their domestic waste to be recycled, we consider the year 1998. In the 1990s, national environmental policy in Italy neither provided monetary incentives nor obliged its inhabitants to separate domestic waste. However, at a local level administrators started encouraging householders to sort their waste and to put the different materials into dedicated bins placed along the street (Legislative Decree 22/1997, the so-called "Ronchi Decree"). Thus, in the year 1998, in the absence of binding rules and extrinsic incentives, it can be affirmed that peoples' effort to sort their household waste and contribute to recycling was mainly driven by intrinsic incentives, such as their concerns regarding environmental issues as well as their social ties.

The paper is organised as follows. Section 2 describes the waste policy in Italy with reference to "The Ronchi Decree", section 3 reviews the literature related to the topics analysed in the present study and section 4 formulates the main research hypothesis. Section 5 contains an overview of the data and describes the empirical strategy, while section 6 provides a discussion on the results of the econometric analysis. Finally, section 7 concludes.

2. Waste policy in Italy: "The Ronchi Decree"

In Italy, until 1996, one of the main policy instruments to tackle waste disposal was taxation (Law 475/1988). Law Decree 22/1997, called the "Ronchi Decree", was adopted to fill gaps in legislation on waste management, and to transpose the main principles and prescriptions of European Union waste policy as embodied in specific norms and regulations concerning municipal, special and packaging waste (respectively 91/156/EC, 91/689/EC, and 94/62/EC). Italian legislation allocated the responsibilities for waste policy among different institutional levels, and introduced the principle of "self sufficiency" under which each region should be held responsible for waste from its own territory and not export waste outside it.

The Ronchi Decree was based on the principle that priority should be given to prevent waste generation and recovery rather than disposal, which should be the last option considered. Special emphasis was placed on separation of waste materials at source. Indeed, the most important goal of Law Decree 22/1997 was to increase separate collection of municipal solid waste with respect to five main components (paper, glass, plastic, aluminium and biodegradable waste). To this end, the Ronchi Decree fixed specific targets for separate collection of municipal solid waste to achieve in different steps (15% by March 1999, 25% by March 2001, and 35% by March 2003). It is worth pointing out that in the early 1990s more than 80% of urban waste produced in Italy was landfilled; while the volume of urban waste collected separately for recycling was below 10% (OECD, 2002). The purpose of introducing minimum targets for separate collection was to trigger a gradual change in the sensitivity and behaviour of residents in Italy with respect to waste collection.

When the law decree was adopted, the majority of Italian households were used to disposing of waste without any separation of recyclable materials. The majority of residents had no suitable motivation to separate waste material at origin since they were unaware of the importance of this practice. Moreover, households were expected to consider recycling a time-consuming activity. Indeed, separate waste collection was initially performed by a drop-off collection system. Households were required to place their different types of separated waste in roadside bins. Furthermore, the Ronchi decree laid the basis for introducing a new charging system, which included specific incentives to reduce waste at source and promote separate collection and recycling. However, the new system was to be applied gradually over an eight-year period (2000–2008) (Ronchi, 2017).

3. Related literature

3.1. Demographic and socio-economic characteristics

Several empirical investigations have found that recycling behaviour among households is influenced by socio-economic variables, such as gender, age, education, income and homeownership. With reference to gender, although some studies find that this variable has a little influence on recycling behaviour (Sidique et al., 2010), others highlight a greater propensity to recycle among women than men (Pearson et al., 2012; Hadjimanolis, 2013; Babaei et al., 2015). Findings regarding age and education are also inconclusive (Tadesse et al., 2008). Several works support the hypothesis that age and educational level are related to recycling

behaviour (Keramitsoglou and Tsagarakis, 2013; Yin et al., 2014). In particular, Barr et al. (2005), Perrin and Barton (2001) and Tabernero et al. (2015) show that older people and individuals with a higher educational level recycle more. However, others point out a negative relationship between these two variables and recycling behaviour (Czaikowski et al., 2014). As for income, most studies find a significant correlation between income and recycling (Berglund, 2006; Gellynck et al., 2011; Czaikowski et al., 2014; Zen et al., 2014). However, while some of these studies show that higher-income households recycle more than those with lower incomes (Czaikowski et al., 2014; Zen et al., 2014), others have found that high incomes are not correlated with high rates of recycling (Gellynck et al., 2011). Finally, results concerning homeownership and recycling levels are less conflicting: Barr et al. (2001), Hage et al. (2009), Nixon and Saphores (2009), and Padilla and Trujillo (2018) all find that homeowners are more likely to be recyclers.

3.2. Extrinsic incentives

A strand of literature investigates waste disposal fees and recycling programmes as drivers of household recycling effort. Several studies on US households find that the introduction of waste fees, such as a unit pricing system, contributes to increase household solid waste recycling (Hong et al., 1993; Fullerton and Kinnaman, 1996; Callan and Thomas, 1997). Other studies show the same findings for European countries (Linderhof et al., 2001; Dijkgraaf and Gradus, 2004; Kipperberg, 2007). Results from more recent contributions suggest that monetary incentives are an effective tool to foster sorting behaviour at the municipal level and can be adapted to achieve further goals such as reduction of total waste per capita (Bucciol et al., 2015). Moreover, some investigations that consider recycling programmes found that curbside programmes increase recycling effort more than drop-off programmes (Hong et al., 1993; Fullerton and Kinnaman, 1996; Jenkins et al., 2003; Kipperberg, 2007).

3.3. Intrinsic incentives: environmental concerns

In the last few decades, there have been many studies on the link between environmental concerns and recycling behaviour (see Bamberg and Möser, 2007; Miafodzyeva and Brandt, 2013 for a review), displaying great differences both in terms of conceptual definitions and measurement tools: different studies come with their own definition and measurement of environmental concern (Tadesse, 2009; Best and Mayerl, 2013). In one line of approach, *environmental concern* refers to interest associated with environmental problems, while the term *environmental attitude* refers to the collection of beliefs, interest and behavioural intentions a person holds regarding environmental issues. In this perspective, environmental concern is one aspect of an environmental attitude (Schultz et al., 2005). In this approach, following research by Stern and colleagues, environmental concerns are differentiated into egoistic, altruistic and biospheric (Stern et al., 1993; Stern and Dietz, 1994). Egoistic concerns focus on the individual: those with egoistic environmental attitudes are concerned about the environment, but their concern is at a personal level. For example, those who hold egoistic environmental attitudes would be concerned about air pollution because of the effects it may have on their health. Altruistic concerns describe an overall concern for all people. People with altruistic environmental attitudes care about environmental issues because such problems affect others. Concerns on a biospheric level refer to issues faced by all living species (Schultz, 2001).

Following Schultz's approach, the empirical studies that have studied the hypothesis that people who are more concerned with environmental issues are more likely to adopt recycling behaviour showed mixed results. Early investigations conducted in the 1980s and 1990s found both no significant correlation (Oskamp et al., 1991; Vining and Ebreo, 1992; Schultz et al., 1995) and a significant correlation, albeit relatively small in the coefficient (Oskamp et al., 1998; Guerin et al., 2001; Schultz et al., 2005). Recent analysis appears to conclude that environmental concerns do indeed have a correlation with recycling behaviour. Tadesse (2009) shows that household recycling behaviour is highly related to an index of environmental concerns for a developing country. In a different vein, Arbués and Villanúa (2016) find that Spanish respondents' concern about the environment is a significant factor influencing the recycling of batteries. Moreover, Jekria and Daud (2016), investigating the link between environmental concern, environmental attitude and recycling behaviour, show that environmental concern is related to attitude, and attitude is linked to recycling behaviour. Nevertheless, other studies show the opposite findings. Sidique et al. (2010) find no significant evidence in favour of a correlation between specific concerns regarding recycling and visits to drop-off recycling sites for an area of Michigan (US). D'Amato et al. (2016) investigate the possibility that household recycling decisions interact with those of waste reduction and explore the potential determinants of such different waste behaviours. Their empirical outcomes for UK point out that waste reduction decisions are positively affected by environmental attitudes, whilst the same attitudes have a non-significant effect on recycling behaviour.

3.4. Intrinsic incentives: social capital

A fourth strand of literature emphasises social capital as a major factor affecting recycling behaviour. According to Coleman, social capital “is not a single entity but a variety of different entities with two elements in common: they all consist of some aspects of social structure, and they facilitate certain actions of actors – whether persons or corporate actors– within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible. Unlike other forms of capital, social capital inheres in the structure of relations between actors and among actors” (Coleman, 1988; S98; Coleman, 1990, 302). For Coleman, social capital is embodied in the relations among persons and these social relationships can give individuals access to resources not otherwise available. Three types of social ties have been identified: bonding, bridging and linking (Pretty, 2003). Bonding social capital describes horizontal ties between similar people. Bridging social capital describes horizontal ties shaping heterogeneous groups of people with different backgrounds. Linking social capital refers to ties between groups at different hierarchical levels. In the literature, social ties have been measured through active and passive membership in organisations, frequency of visiting friends and relatives as well as civic and moral norms.

Owen and Videras (2006), using data from the World Values Survey, found that individuals who are more willing to behave according to civic norms are also more willing to protect the public good of the natural environment. Owen and Videras (2007) and Videras et al. (2012) using OECD and US datasets, respectively, extended the results of Owen and Videras (2006) to church groups (and churchgoing) and social ties. Jin (2013), with data from the International Social Survey Programme, showed that participation in voluntary activities is positively related with recycling. Finally, Crociata et al. (2015, 2016) and Agovino et al. (2016), using Italian data, reported that cultural participation, membership in environmental associations and voluntary activities are drivers of recycling behaviour.

4. Theory and empirical hypothesis

The present study takes up the theoretical approach proposed by Stern et al. (1993), according to which people develop their concerns about the environment when they are aware that environmental conditions may result in harmful consequences to the objects they value and they can take action to reduce such effects to the valued objects. Specifically, they propose the idea of different types of concerns based on three value orientations driving people's environmental behaviours: (i) egoistic value orientation as self-enhancement; (ii) altruistic value orientation toward other human beings; (iii) biospheric value orientation interpreted as altruism toward non-human species. The three types of values all enshrine concern for the environment, but each addresses different valued objects. Those who hold egoistic values are concerned about the environment, but their concern is at a personal level. Individuals with altruistic values care about environmental problems because they affect other people. Biospheric values describe an overall concern for all living species.

We build empirical hypotheses regarding the sign and magnitude of the relationship between general environmental concerns and household waste recycling behaviour. Following Kirakozian (2016), we consider a householder who incurs a marginal cost (MC) in sorting and obtains a marginal benefit (MB) when a unit of waste is reused. We assume that the marginal cost is related to the number of separate waste collections while the marginal benefit is connected to environmental concerns.

The householder with egoistic concerns pays attention to the welfare of his/her household. In the absence of incentives (penalties), he/she is willing to adopt waste recycling behaviour if general environmental problems are perceived to impact upon his/her household's well-being. Hence for this type of householder, MB [egoistic concerns] > MC. Let us make the first empirical hypothesis:

H1. We would expect a positive relationship between egoistic environmental concerns and household waste recycling if general environmental issues are perceived as a threat to the household's own welfare.

The householder with altruistic environmental concerns takes care of the welfare of others. He/she perceives other households' benefits linked to waste recycling as higher than his/her own household's costs. Hence, also for this type of householder, MB [altruistic concerns] > MC. Let us pose the second empirical hypothesis:

H2. We would expect a positive correlation between altruistic environmental concerns and household waste recycling if general environmental issues are seen as a threat to the welfare of other households.

The householder with biospheric environmental concerns behaves carefully with all living species. He/she recognizes benefits for all living species connected to waste recycling as higher than his/her own household costs. Thus, as well for this type of householder, MB[biospheric concerns] > MC. Let us pose the third empirical hypothesis:

H3. We would expect a positive association between biospheric environmental concerns and household waste recycling if general environmental issues are seen as a threat to all living species.

The number of separate waste collections that a householder has to carry out influences his/her recycling behaviour through marginal costs. Indeed, as the number of separate waste collections increases (paper, glass, plastic, food waste, etc…), the costs related to sorting rise too (costs of domestic recycling bins, costs for transporting waste to recycling bins placed along the streets, opportunity cost of time, etc…). Hence, the magnitude of the positive correlation among egoistic, altruistic and biospheric environmental concerns and household waste recycling might decrease as the number of separate waste collections increases. This leads to the fourth empirical hypothesis:

H4. We would expect a decreasing magnitude of the positive correlation between general environmental concerns and household waste recycling when the number of separate waste collections increases.

In the empirical analysis, we investigate the correlation between household waste recycling behaviour related to the households' efforts to make multiple separate waste collection and general environmental concerns as classified by the theoretical approach, that is egoistic, altruistic and biospheric. To this end, we group environmental issues on which our sample was tested into five variables: (i) waste production and disposal; (ii) pollution; (iii) climate change; (iv) resource depletion; and (v) alteration of environmental heritage. We propose to interpret waste production and disposal as egoistic concerns, environmental pollution and climate change as altruistic environmental concerns, and resource depletion and alteration of environmental heritage as biospheric concerns.

5. Data and empirical strategy

The study uses the Multipurpose Household Survey (MHS), year 1998, conducted by the National Institute of Statistics (ISTAT). This large dataset is one of the best available for studying environmental concerns and pro-environmental behaviour in a cross-section framework since it investigates a wide range of behaviour by means of face-to-face interviews on a sample of about 20,000 households, roughly corresponding to 60,000 individuals. The final dataset used in the empirical analysis contains 26,168 observations. The unit of analysis is the householder. Table A.1 in Appendix A accounts for the definitions of all variables used in the econometric analysis.

Table 1 shows weighted summary statistics while Table 2 reports weighted correlations among the dependent and key independent variables.

Table 1
Weighted descriptive statistics.

Variable	Mean	S.D.	Minimum	Maximum
Dependent variables				
At least one recycling	0.646	0.478	0	1
At least two recyclings	0.530	0.499	0	1
At least three recyclings	0.422	0.493	0	1
At least four recyclings	0.267	0.442	0	1
All five recyclings	0.198	0.398	0	1
Key independent variables: environmental concerns				
EC1. Waste production and disposal	0.225	0.417	0	1
EC2. Pollution	1.373	0.992	0	5
EC3. Climate change	0.937	0.714	0	2
EC4. Resource depletion	0.396	0.566	0	2
EC5.Alteration of env. heritage	0.315	0.519	0	2
Policy variables				
Judgment on waste disposal fee	0.670	0.470	0	1
At least one recycling bin	0.651	0.477	0	1
At least two recycling bins	0.533	0.499	0	1
At least three recycling bins	0.429	0.495	0	1
At least four recycling bins	0.273	0.445	0	1
All five recycling bins	0.168	0.374	0	1
Demographic and socio-economic characteristics				
Female	0.224	0.417	0	1

(*continued on next page*)

Table 1 (*continued*)

Variable	Mean	S.D.	Minimum	Maximum
Married	0.685	0.464	0	1
Divorced	0.066	0.249	0	1
Widowed	0.138	0.345	0	1
Age31-40	0.191	0.393	0	1
Age41-50	0.204	0.403	0	1
Age51-60	0.200	0.400	0	1
Age61-70	0.194	0.395	0	1
Age71-80	0.152	0.359	0	1
Household size	2.75	1.29	1	12
Children0_5	0.154	0.424	0	4
Children6_12	0.190	0.476	0	4
Children13_17	0.150	0.415	0	4
Low education	0.652	0.476	0	1
Bachelor's degree	0.083	0.275	0	1
Household income (ln)	10.633	0.461	8.686	12.191
Poor health	0.084	0.278	0	1
Good health	0.720	0.449	0	1
Unemployed	0.029	0.168	0	1
Entrepreneur	0.067	0.249	0	1
Self-employed	0.098	0.297	0	1
Retired	0.337	0.473	0	1
Homeowner	0.693	0.461	0	1
Council house	0.621	0.485	0	1
Rooms	3.133	1.747	1	5
Perception of community problems				
Micro-criminality	0.027	0.163	0	1
No parking problems	0.356	0.479	0	1
No traffic problems	0.212	0.409	0	1
No pollution	0.260	0.439	0	1
No dirtiness problems	0.255	0.436	0	1
City size				
Metropolis	0.242	0.429	0	1
Neighbouring metropolis	0.075	0.264	0	1
>50,000	0.152	0.360	0	1
10,000–50,000	0.213	0.409	0	1
2,000–10,000	0.242	0.428	0	1
Social capital variables				
Passive membership	0.255	0.436	0	1
Active membership	0.137	0.344	0	1
Meeting friends	0.668	0.471	0.	1
Visiting relatives	0.299	0.458	0	1
Church attendance	0.327	0.469	0	1
Talking politics	0.442	0.497	0	1
Listening to politics	0.239	0.426	0	1
Newspapers	0.296	0.456	0	1
Television	0.881	0.324	0	1
Radio	0.396	0.489	0	1

5.1. Dependent variables

Household waste recycling is measured through the question "Does the family usually do separate waste collection and place materials in assigned recycling bins?", where possible responses are: yes always, yes sometimes, never. Responses are re-coded into a binary variable, which is equal to 1 in cases of "yes always" and 0 otherwise.

Five different materials are considered: paper, glass, plastic, aluminium and food waste. Five household waste recycling binary variables are built according to the number of waste separate collections:

(i) *at least one recycling*, equal to 1 if the householder recycles at least one material among paper, plastic, glass, aluminium and food waste, and 0 otherwise;
(ii) *at least two recyclings,* equal to 1 if the householder recycles at least two materials among paper, plastic, glass, aluminium and food waste, and 0 otherwise;
(iii) *at least three recyclings*, equal to 1 if the householder recycles at least three materials among paper, plastic, glass, aluminium and food waste, and 0 otherwise;
(iv) *at least four recyclings*, equal to 1 if the householder recycles at least four materials among paper, plastic, glass, aluminium and food waste, and 0 otherwise;
(v) *all five recyclings*, equal to 1 if the householder recycles all five materials, 0 otherwise.

As we can see in Table 1, average household waste recycling is between 65%, in the case of at least one material, and 20%, in the case of all five materials.

5.2. General environmental concerns

In the 1998 wave of the MHS dataset the question: "What are the worrying environmental problems?" is used to build proxies for general environmental concerns. Respondents could choose five answers among the following: (i) greenhouse effect; (ii) species extinction; (iii) climate change; (iv) noise; (v) waste production and disposal; (vi) air pollution; (vii) soil pollution; (viii) water pollution; (ix) destruction of forests; (x) electromagnetic pollution; (xi) destruction of landscape; (xii) depletion of natural resources.

We propose to group the specific environmental concerns on which our sample was tested into five different issues. We add 1 to the environmental concern variable when the respondent states that he/she agrees with the related environmental issue. The five general environmental concerns variables are:

EC1. Waste production and disposal;
EC2. Pollution (noise; air, soil, water, electromagnetic);
EC3. Climate change (greenhouse effect, climate change);
EC4. Resource depletion (destruction of forests, depletion of natural resources);
EC5. Alteration of environmental heritage (species extinction, destruction of the landscape).

The sample average and the standard deviation of these variables are indicated in Table 1. We can see that the highest means are over pollution, 1.37, and climate change, 0.94, followed by resource depletion, 0.40, and alteration of environmental heritage, 0.31. The lowest mean is for waste production and disposal, 0.22. Table 2 shows statistically significant correlations among all the dependent and environmental concern variables.

Table 2
Correlations among dependent and key independent variables.

	At least one recycling	At least two recyclings	At least three recyclings	At least four recyclings	Five recyclings
EC1	0.045*	0.055*	0.056*	0.051*	0.051*
EC2	0.072*	0.078*	0.078*	0.060*	0.048*
EC3	0.038*	0.037*	0.033*	0.027*	0.019*
EC4	0.061*	0.063*	0.069*	0.063*	0.053*
EC5	0.052*	0.067*	0.076*	0.067*	0.065*

Note: statistically significant at 5 percent level.

5.3. Policy variables

Waste disposal fees and recycling infrastructure are fundamental parts of any recycling policy (Perrin and Barton, 2001). In MHS, the policy information available for econometric analysis is the judgment of the household head on the waste disposal fee and on the presence of recycling bins for waste. We create a dummy variable labelled "Judgment on waste disposal fee" if the household head believes the cost of the waste disposal service is high.

The MSH asks the question: "Are there recycling bins for separate waste collection in the area where the household lives?". The answers are: 1) yes and easy to reach; 2) yes but difficult to reach; 3) no; 4) I do not know. Responses (1) and (2) are used to build a dummy variable for recycling bins for each of the five materials. Moreover, five recycling bin variables are built according to the number of waste separate collections: at least one recycling bin (*At least one recycling bin*), at least two recycling bins (*At least two recycling bins*), at least three recycling bins (*At least three recycling bins*), at least four recycling bins *(At least four recycling bins*) and all five recycling bins (*Five recycling bins*).

5.4. Demographic and socioeconomic characteristics

We use many demographic and socio-economic characteristics as control variables such as gender, marital status, age, household size, age of children, education level, household income, self-reported health, employment status, tenure status and property characteristics. We also control for the quality of the surrounding environment where the respondent lives. These variables measure the respondent's beliefs regarding potential environmental problems related to the area where he/she lives. Finally, we control for city size and regional dummies. Regional fixed effects are also included to account for the high regional heterogeneity in economic development and environmental quality existing in Italy.

5.5. Social capital variables

These variables measure a variety of social ties, civic and social norms that capture different links with household waste recycling. They are as follows:

1. Bonding social capital: *relationships with friends and relatives* (frequency of meetings with friends and relatives every day or at least twice a week);
2. Bridging social capital: *passive and active membership* (if the respondent participated in meetings of or did unpaid work for an association in the 12 months prior to the interview);
3. Linking social capital: *political interest* (the habit of talking politics every day or more than once a week and the habit of listening to political debates);
4. *Church attendance* (if the respondent goes to a church or other place of worship one or more times a week);
5. *The habit of reading newspapers, watching television and listening to the radio* (read newspapers, watch television and listen to the radio, every day).

5.6. Empirical strategy

We empirically model the relationship between environmental concerns and the number of separate waste collections using five latent variable models:

$$REC1^{*} = \alpha_1 + \boldsymbol{X\beta} + \boldsymbol{C\delta} + \varepsilon,\ REC1 = 1\left[REC1^{*} > 0\right] \tag{1}$$

$$REC2^{*} = \alpha_2 + \boldsymbol{X\gamma} + \boldsymbol{C\rho} + \mu,\ REC2 = 1\left[REC2^{*} > 1\right] \tag{2}$$

$$REC3^{*} = \alpha_3 + \boldsymbol{X\theta} + \boldsymbol{C\vartheta} + \tau,\ REC3 = 1\left[REC3^{*} > 2\right] \tag{3}$$

$$REC4^{*} = \alpha_4 + \boldsymbol{X\sigma} + \boldsymbol{C\phi} + \omega,\ REC4 = 1\left[REC4^{*} > 3\right] \tag{4}$$

$$REC5^{*} = \alpha_5 + \boldsymbol{X\chi} + \boldsymbol{C}\phi + \upsilon,\ REC5 = 1\left[REC5^{*} > 4\right] \tag{5}$$

where $REC1^{*} - REC5^{*}$ is the increasing number of separate waste collections; $\boldsymbol{X}$ is the matrix of demographic and socio-economic characteristics and the other variables that are known to influence household waste recycling behaviour; $\boldsymbol{C}$ is the matrix of environmental concerns; $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, $\boldsymbol{\theta}$, $\boldsymbol{\sigma}$, $\boldsymbol{\chi}$, $\boldsymbol{\delta}$, $\boldsymbol{\rho}$, $\boldsymbol{\vartheta}$, $\boldsymbol{\phi}$, ϕ are the parameters to be estimated and $\varepsilon, \mu, \tau, \omega, \upsilon$ are the random-error terms. The function $1[\cdot]$ defines a binary outcome, which takes on the value one if the event in brackets is true, and zero otherwise. Hence:

REC1 = 1 if the householder recycles at least one material;
REC2 = 1 if the householder recycles at least two materials;
REC3 = 1 if the householder recycles at least three materials;
REC4 = 1 if the householder recycles at least four materials;
REC5 = 1 if the householder recycles all the five materials.

Assuming that the random-error terms are independent of $\boldsymbol{X}$ and $\boldsymbol{C}$ and the random-error terms have the standard normal distribution, we obtain five probit models:

$$\Pr(REC1 = 1|\boldsymbol{X}, \boldsymbol{C}) = \Phi(\alpha_1 + \boldsymbol{X\beta} + \boldsymbol{C\delta}) \tag{6}$$

$$\Pr(REC2 = 1|\boldsymbol{X}, \boldsymbol{C}) = \Phi(\alpha_2 + \boldsymbol{X\gamma} + \boldsymbol{C\rho}) \tag{7}$$

$$\Pr(REC3 = 1|\boldsymbol{X}, \boldsymbol{C}) = \Phi(\alpha_3 + \boldsymbol{X\theta} + \boldsymbol{C\vartheta}) \tag{8}$$

$$\Pr(REC4 = 1|\boldsymbol{X}, \boldsymbol{C}) = \Phi(\alpha_4 + \boldsymbol{X\sigma} + \boldsymbol{C\phi}) \tag{9}$$

$$\Pr(REC5 = 1|\boldsymbol{X}, \boldsymbol{C}) = \Phi(\alpha_5 + \boldsymbol{X\chi} + \boldsymbol{C}\phi) \tag{10}$$

where $\Phi(\cdot)$ is the cumulative distribution function of a normal standard.

6. Econometric results

In Table 3, Columns (I) – (V) show the coefficients and standard errors, corrected for heteroskedasticity, of the probit estimations of Equation (6) – (10). Marginal effects of variables statistically significant are reported in Columns (I) – (V) of Table 4. In the first section, we discuss the relationship between household waste recycling and environmental concerns. In the second and third sections, policy variables and socio-economic characteristics are considered. In the last section, the social capital variables are examined.

6.1. Environmental concerns

We begin by commenting on the findings on egoistic, altruistic and biospheric environmental concern variables. Through REC1 – REC5 in Table 3, we note that all variables, i.e., *waste production and disposal*, *pollution*, *climate change*, *resource depletion* and *alteration*

Table 3
Probit results: coefficients.

Variable	I	II	III	IV	V
	REC1	REC2	REC3	REC4	REC5
	At least one recycling	*At least two recyclings*	*At least three recyclings*	*At least four recyclings*	*All five recyclings*
Key independent variables: environmental concerns					
EC1. Waste production and d.	0.083***(0.022)	0.108***(0.022)	0.099***(0.022)	0.113***(0.024)	0.108***(0.026)
EC2. Pollution	0.054***(0.009)	0.054***(0.009)	0.062***(0.010)	0.048***(0.011)	0.038***(0.012)
EC3. Climate change	0.089***(0.013)	0.092***(0.013)	0.089***(0.014)	0.086***(0.015)	0.080***(0.017)
EC4. Resource depletion	0.097***(0.017)	0.101***(0.017)	0.116***(0.017)	0.087***(0.018)	0.060***(0.020)
EC5.Alteration of env. heritage	0.065***(0.018)	0.088***(0.018)	0.115***(0.018)	0.098***(0.020)	0.093***(0.022)
Policy variables					
Judgment on waste disposal fee	−0.009(0.020)	−0.030(0.020)	−0.014(0.020)	−0.012(0.022)	0.001(0.004)
At least one recycling bin	0.731***(0.019)				
At least two recycling bins		0.621***(0.019)			
At least three recycling bins			0.754***(0.019)		
At least four recycling bins				0.903***(0.022)	
All five recycling bins					1.028***(0.026)
Demographic and socio-economic characteristics					
Female	0.135***(0.033)	0.170***(0.033)	0.101***(0.034)	0.064*(0.037)	0.034(0.041)
Married	0.116***(0.038)	0.115***(0.038)	0.108***(0.040)	0.100**(0.043)	0.061(0.048)
Divorced	−0.061(0.044)	−0.067(0.044)	−0.045(0.045)	−0.033(0.050)	0.014(0.055)
Widowed	−0.017(0.041)	−0.024(0.042)	0.006(0.043)	−0.032(0.048)	−0.056(0.053)
Age31-40	0.010(0.047)	0.039(0.047)	0.059(0.049)	0.092*(0.054)	0.077(0.060)
Age41-50	0.054(0.050)	0.101**(0.050)	0.104**(0.052)	0.101*(0.054)	0.040(0.064)
Age51-60	0.064(0.053)	0.148***(0.053)	0.161***(0.054)	0.152**(0.060)	0.146**(0.067)
Age61-70	0.061(0.057)	0.153***(0.057)	0.155***(0.059)	0.128*(0.066)	0.137*(0.074)
Age71-80	−0.101(0.063)	0.005(0.063)	0.001(0.065)	−0.001(0.073)	0.080(0.082)
Household size	0.004(0.013)	0.008(0.013)	0.005(0.013)	−0.012(0.015)	0.010(0.017)
Children0_5	−0.026(0.029)	−0.034(0.029)	−0.020(0.030)	−0.042(0.033)	−0.051(0.036)
Children6_12	−0.000(0.023)	−0.011(0.024)	−0.014(0.025)	0.016(0.027)	0.000(0.030)
Children13_17	−0.014(0.027)	−0.006(0.027)	−0.002(0.028)	0.021(0.031)	0.003(0.035)
Low education	−0.077***(0.028)	−0.110***(0.028)	−0.115***(0.029)	−0.045(0.032)	−0.002(0.035)
Bachelor's degree	0.065*(0.038)	0.055(0.037)	0.002(0.038)	−0.011(0.010)	0.028(0.045)
Household income (ln)	0.145***(0.045)	0.138***(0.045)	0.0131***(0.047)	0.130**(0.052)	0.035(0.058)
Poor health	−0.080**(0.038)	−0.094**(0.038)	−0.083**(0.040)	−0.028(0.045)	−0.040(0.050)
Good health	−0.026(0.025)	−0.015(0.025)	−0.043*(0.026)	−0.038(0.028)	−0.042(0.031)
Unemployed	−0.115**(0.052)	−0.060(0.055)	−0.092(0.062)	−0.032(0.067)	−0.086(0.081)
Entrepreneur	−0.006(0.039)	−0.059(0.039)	−0.069*(0.040)	−0.023(0.043)	0.007(0.047)
Self-employed	−0.031(0.034)	−0.082**(0.034)	−0.126***(0.035)	−0.094***(0.039)	−0.029(0.043)
Retired	0.153***(0.030)	0.118***(0.030)	0.112***(0.031)	0.122***(0.034)	0.062(0.038)
Homeowner	0.030(0.025)	0.033(0.025)	0.045*(0.027)	0.034(0.029)	0.077**(0.033)
Council house	0.021(0.019)	0.040**(0.019)	0.069***(0.020)	0.036*(0.022)	−0.001(0.024)
Rooms	0.009*(0.005)	0.012**(0.005)	0.013**(0.006)	0.015**(0.006)	0.013*(0.007)
Perception of community problems					
Micro-criminality	0.054(0.056)	0.026(0.055)	0.021(0.058)	0.038(0.061)	0.019(0.069)
No parking problems	0.078***(0.023)	0.079***(0.023)	0.090***(0.024)	0.059**(0.026)	0.081***(0.028)
No traffic problems	−0.035(0.030)	−0.045(0.030)	−0.039(0.031)	0.021(0.034)	0.074**(0.037)
No pollution	0.044(0.027)	−0.013(0.027)	−0.009(0.029)	−0.067**(0.032)	−0.070*(0.036)
No dirtiness problems	0.034(0.023)	0.022(0.023)	0.012(0.024)	0.044*(0.026)	0.038(0.028)
City size					
Metropolis	−0.081**(0.038)	−0.084**(0.038)	−0.062(0.039)	−0.096**(0.042)	−0.086*(0.047)
Neighbouring metropolis	−0.069(0.047)	−0.051(0.047)	−0.014(0.048)	−0.014(0.052)	−0.066(0.058)
>50,000	−0.117***(0.041)	−0.124***(0.040)	−0.094**(0.041)	−0.076*(0.045)	−0.047(0.050)
10,000–50,000	−0.084**(0.039)	−0.073*(0.039)	−0.064(0.039)	−0.046(0.043)	−0.039(0.047)
2,000–10,000	−0.066*(0.038)	−0.110***(0.038)	−0.111***(0.039)	−0.127***(0.042)	−0.091*(0.047)
Social capital variables					
Meeting friends	0.060***(0.020)	0.030(0.020)	0.004(0.021)	0.003(0.022)	0.041(0.025)
Visiting relatives	0.004(0.021)	−0.001(0.021)	0.001(0.022)	−0.013(0.024)	−0.001(0.027)
Passive membership	0.136***(0.026)	0.140***(0.026)	0.132***(0.026)	0.095***(0.028)	0.065**(0.031)
Active membership	0.097***(0.033)	0.115***(0.032)	0.101***(0.032)	0.086**(0.034)	0.095**(0.037)
Talking politics	0.047**(0.020)	0.088***(0.020)	0.079***(0.021)	0.037(0.023)	0.048*(0.025)
Listening to politics	0.054**(0.022)	0.070***(0.022)	0.048**(0.022)	0.017(0.024)	0.027(0.027)
Church attendance	0.089***(0.021)	0.089***(0.021)	0.086***(0.022)	0.071***(0.024)	0.107***(0.026)
Newspapers	0.039*(0.022)	0.064***(0.021)	0.065***(0.022)	0.081***(0.024)	0.046*(0.026)
Television	0.024(0.029)	0.024(0.029)	0.009(0.030)	0.006(0.032)	−0.038(0.036)
Radio	0.045**(0.019)	0.051***(0.019)	0.023(0.019)	0.028(0.021)	0.010(0.023)
Regional dummies	Yes	Yes	Yes	Yes	Yes
No. of observations	24,474	23,920	23,879	23,857	23,678
Pseudo R-squared	0.237	0.250	0.280	0.273	0.276
Log-likelihood	−12,420.48	−12,434.66	−11,445.99	−9,368.01	−7,471.70

Notes: Regressors' legend: see Table A1. Regional dummies are omitted from the Table for reasons of space. The standard errors are corrected for heteroskedasticity. The symbols ***, **, * denote that the coefficient is statistically different from zero at 1, 5 and 10%, respectively.

Table 4
Probit results: marginal effects of statistically significant variables.

Variable	I	II	III	IV	V
	REC1	REC2	REC3	REC4	REC5
	At least one recycling	*At least two recyclings*	*At least three recyclings*	*At least four recyclings*	*All five recyclings*
Key independent variables: environmental concerns					
EC1. Waste production and d.	0.030***(0.008)	0.043***(0.009)	0.036***(0.008)	0.028***(0.006)	0.018***(0.005)
EC2. Pollution	0.020***(0.003)	0.021***(0.004)	0.023***(0.004)	0.012***(0.003)	0.006***(0.002)
EC3. Climate change	0.033***(0.005)	0.037***(0.005)	0.033***(0.005)	0.021***(0.004)	0.014***(0.003)
EC4. Resource depletion	0.036***(0.006)	0.040***(0.007)	0.043***(0.006)	0.022***(0.005)	0.010***(0.003)
EC5.Alteration of env. heritage	0.024***(0.007)	0.035***(0.007)	0.042***(0.007)	0.025***(0.005)	0.016***(0.004)
Policy variables					
At least one recycling bin	0.270***(0.007)				
At least two recycling bins		0.248***(0.008)			
At least three recycling bins			0.278***(0.007)		
At least four recycling bins				0.225***(0.005)	
All five recycling bins					0.176***(0.008)
Demographic and socio-economic characteristics					
Female	0.050***(0.012)	0.068***(0.013)	0.037***(0.012)	0.016*(0.009)	0.006(0.007)
Married	0.043***(0.014)	0.046***(0.015)	0.040***(0.014)	0.025**(0.011)	0.010(0.008)
Age41-50	0.020(0.018)	0.040**(0.020)	0.038**(0.019)	0.025*(0.014)	0.007(0.011)
Age51-60	0.023(0.019)	0.059***(0.021)	0.059***(0.020)	0.038**(0.015)	0.025**(0.013)
Age61-70	0.022(0.021)	0.061***(0.023)	0.057***(0.022)	0.032*(0.016)	0.024*(0.013)
Low education	−0.029***(0.010)	−0.044***(0.011)	−0.042***(0.011)	−0.011(0.008)	−0.000(0.006)
Bachelor's degree	0.024*(0.014)	0.022(0.015)	0.000(0.014)	−0.011(0.010)	0.005(0.008)
Household income (ln)	0.054***(0.016)	0.055***(0.018)	0.048***(0.017)	0.032**(0.013)	0.006(0.010)
Poor health	−0.030**(0.014)	−0.037**(0.015)	−0.030**(0.015)	−0.007(0.011)	−0.007(0.008)
Unemployed	−0.042**(0.020)	−0.024(0.022)	−0.034(0.023)	−0.008(0.017)	−0.015(0.013)
Self-employed	−0.011(0.012)	−0.033**(0.013)	−0.046***(0.013)	−0.023***(0.010)	−0.005(0.007)
Retired	0.056***(0.011)	0.047***(0.012)	0.041***(0.011)	0.030***(0.009)	0.011(0.007)
Homeowner	0.011(0.009)	0.013(0.010)	0.017*(0.010)	0.008(0.007)	0.013**(0.006)
Council house	0.008(0.007)	0.016**(0.008)	0.025***(0.007)	0.009*(0.005)	−0.000(0.004)
Rooms	0.003*(0.002)	0.005**(0.002)	0.005**(0.002)	0.004**(0.002)	0.002*(0.001)
Perception of community problems					
No parking problems	0.029***(0.008)	0.031***(0.009)	0.033***(0.009)	0.015**(0.006)	0.014***(0.005)
No traffic problems	−0.013(0.010)	−0.018(0.012)	−0.014(0.011)	0.005(0.008)	0.013**(0.007)
No pollution	0.016(0.010)	−0.005(0.011)	−0.003(0.010)	−0.017**(0.008)	−0.012*(0.006)
City size					
Metropolis	−0.030**(0.014)	−0.033***(0.015)	−0.023(0.014)	−0.024**(0.010)	−0.015*(0.008)
>50,000	−0.043***(0.015)	−0.049***(0.016)	−0.035**(0.015)	−0.019*(0.011)	−0.008(0.008)
10,000–50,000	−0.031**(0.014)	−0.029*(0.015)	−0.023(0.014)	−0.011(0.011)	−0.007(0.008)
2,000–10,000	−0.024*(0.014)	−0.044***(0.015)	−0.041***(0.014)	−0.032***(0.011)	−0.015*(0.007)
Social capital variables					
Meeting friends	0.022***(0.007)	0.012(0.008)	0.002(0.007)	0.001(0.006)	0.007(0.004)
Passive membership	0.050***(0.010)	0.056***(0.010)	0.048***(0.010)	0.024***(0.007)	0.011**(0.005)
Active membership	0.036***(0.012)	0.046***(0.013)	0.037***(0.012)	0.021**(0.009)	0.016**(0.006)
Talking politics	0.017**(0.008)	0.035***(0.008)	0.029***(0.008)	0.009(0.006)	0.008*(0.004)
Listening to politics	0.020**(0.008)	0.028***(0.009)	0.018**(0.008)	0.004(0.006)	0.005(0.005)
Church attendance	0.033***(0.008)	0.036***(0.008)	0.031***(0.008)	0.018***(0.006)	0.018***(0.004)
Newspapers	0.014*(0.008)	0.026***(0.008)	0.024***(0.008)	0.020***(0.006)	0.008*(0.004)
Radio	0.017**(0.007)	0.020***(0.007)	0.008(0.007)	0.007(0.005)	0.002(0.004)

Note: The symbols ***, **, * denote that the marginal effect is statistically different from zero at 1, 5 and 10%, respectively.

of environmental heritage, are statistically significant at the 1 percent level and positively associated with household waste recycling. A greater concern for waste production and disposal, pollution, climate change, resource depletion and alteration of environmental heritage is related to a higher likelihood of doing household waste recycling. These findings are in line with previous studies according to which individuals who have an environmental concern recycle more (Tadesse, 2009; Nnorom et al., 2009; Arbués and Villanúa, 2016).

In Section 2, we interpreted *waste production and disposal* as egoistic concerns, *pollution* and *climate change* as altruistic, *resource depletion* and *alteration of environmental heritage* as biospheric concerns. Hence, the results on environmental concerns, EC1 – EC5, fit the empirical hypotheses H1, H2 and H3 of Section 2. Findings on *waste production and disposal* indicate that when the householder recognizes this environmental issue as a threat to the welfare of his/her own family, he/she will recycle at source. *Pollution* and *climate change* point out that if the householder perceives these general environmental issues as a threat to the welfare of households in the group of which he/she is part, he/she will also recycle at source. Results on *resource depletion* and *alteration of environmental heritage* indicate that if the householder perceives these general environmental issues as a threat for all living species, he/she will recycle too.

Through Columns (I) – (V) of Table 4, we also observe that the magnitude of the marginal effects of all environmental concern variables change. In other words, as the number of separate waste collections increases, the marginal effects of EC1 – EC5 variables change: they first increase and then decrease. In the case of at least one separate waste collection, REC1, the marginal effects of environmental concern variables are included in a range between 2 (*pollution*) and 3.6 percent (*resource depletion*). As the number of separate waste collections increases by another unit, REC4, the marginal effects of all environmental concern variables decline. In particular, from REC3 to REC4, the marginal effects decrease by (percent): 0.8 *waste production and disposal*; 1.1 *pollution*; 1.2

climate change; 2.1 *resource depletion*; 1.7 *alteration of environmental heritage*.

Finally, in the case of all five separate waste collection, REC5, the marginal effects of all environmental concern variables decline further. They are included in a range between 0.6 (*pollution*) and 1.8 percent (*waste production and disposal*).

Hence, for highest number of separate waste collections the magnitude of the marginal effect of the egoistic, altruistic and biospheric concern variables decreases. These findings seem to fit the empirical hypothesis H4 of Section 2. A feasible explanation of these results is that as the number of separate waste collections increases the marginal costs of sorting rise too.

6.2. Policy variables

The findings reported in Table 3 show that the variable, which measures the opinion of the householder on the waste disposal fee, is not associated to household waste recycling behaviour. Through REC1 – REC5, *judgment on waste disposal* fee is not statistically significant. In all columns, the recycling bins programme has a positive and significant correlation with all dependent variables. This result is in line with previous investigations which highlight the lack of facilities as a barrier to waste management (Perrin and Barton, 2001; Kipperberg, 2007). The magnitude of the marginal effect of recycling bins varies across the number of separate waste collections with the highest marginal effect, 28%, for *at least three recycling bins* and the lowest marginal effect, 18%, for *all five recycling bins*.

6.3. Demographic and socioeconomic characteristics

The econometric analysis presented in Table 3 includes the socioeconomic characteristics of householders. We discuss those variables that have a statistically significant sign.

Being female and married increases the likelihood of recycling from one to four materials. The marginal effects on *female* and *married* have a positive sign and are statistically significant at the 1 percent level in REC1 – REC3, whereas they decrease, respectively, at the 10 and 5 percent level in REC4. Regarding gender and marital status, several works have found evidence that women and married individuals are more likely to recycle than men and the unmarried (Pearson et al., 2012; Babaei et al., 2015; Padilla and Trujillo, 2018).

Age dummies exhibit a non-linear relationship with recycling behaviour. In particular, being in the age class between 41 and 50 is linked to a higher likelihood of making separate waste collection from REC2 to REC3 (significant at 5%). Moreover, the age class between 51 and 60 is related to a higher probability of recycling waste from at least two to all five materials (significant at least at 5%). Finally, the age class between 61 and 70 is related to a higher probability of doing separate waste collection from at least two to all five materials (significant at least at 10%). The association between age dummies and recycling behaviour is in line with previous studies (Sidique et al., 2010; Hadjimanolis, 2013).

Low education shows a negative sign and is statistically significant at 1 percent level in REC1 – REC3. This evidence indicates that a householder who completed elementary and/or junior high school recycles less than a household head with high school education. In the case of at least one separate waste collection, it also results that university graduates have a higher likelihood of recycling than high school-leavers. The result of a positive correlation between high school and recycling behaviour is consistent with the findings of previous works (Czaikowski et al., 2014; Yin et al., 2014; Padilla and Trujillo, 2018).

Household income has a positive sign in the first four regressions (REC1- REC4) and is statistically significant at conventional level. This means that household recycling behaviour is a normal good. This result is in line with one strand of the literature (Gellynck et al., 2011; Zen et al., 2014).

Perceived health and employment status are also determinants of household waste recycling. A household head who perceives his/her health status as poor is less likely to recycle from at least one to at least three materials (significant at 5%). With respect to employment status, in REC1, the *unemployed* recycle less than the employed (significant at 5%). In REC2 - REC4, the *self-employed* recycle less than the employed (significant at 1%). Finally, being retired is related to a higher likelihood of recycling from at least one to at least four materials (significant at 1%).

Recycling behaviour is also correlated to homeownership, living in social housing and number of rooms. Homeowners are more likely than tenants to recycle at least two, three and all five materials. This result is in line with previous investigations (Barr et al., 2001; Nixon and Saphores, 2009; Padilla and Trujillo, 2018). Moreover, living in social housing is correlated with a higher likelihood of doing at least two, three and four separate waste collections. Furthermore, living in a house with a large number of rooms is positively related to a higher probability of recycling from REC1 to REC5. A household head who states that there are no parking problems in the area where he/she lives has a higher probability of recycling from at least one to all five materials (significant at 1% level). Moreover, a householder who states that there are no traffic problems in the area where he/she lives has a higher likelihood of recycling all five materials (significant at 5% level).

Finally, settlement size comes into the recycling equations with a negative sign and is statistically significant. A householder who lives in a municipality with more than 2,000 inhabitants recycles less, with the exception of the respondent who lives in a municipality close to a metropolitan area.

6.4. Social capital variables

Table 3, Columns (I) – (V) show interesting findings regarding the relationship between social capital variables and the number of separate waste collections.

Bonding social capital is only statistically significant in *meeting friends* in REC1 and REC2 while *visiting relatives* is never statistically significant in all the regressions. In the latter case, a plausible explanation could be that rules, norms and sanctions within the family do not ensure that collective interests, such as environmental protection, are complementary with the private interests of householders (Pretty, 2003). In other words, environmental issues lie outside the primary interests of the household. With regard to friends, the number of friends a person interacts with and the frequency of such relations determine access to information, including information on environmental issues (Videras et al., 2012). Moreover, support from friends can reduce the costs in engaging in recycling effort. Hence, information and support from friends may explain the positive relationship between meeting friends and REC1 and REC2. Nevertheless, the frequency of contact with friends would not appear to develop peer pressure on individuals in the internalization of environmental norms.

Bridging social capital is statistically significant in all regressions (at least 5%). Passive and active membership in formal organisations is positively correlated with a higher likelihood of the householder recycling from at least one material to all five. However, the magnitude of the marginal effect of *passive membership* and *active membership* decreases as the number of separate waste collection increases (see Table 4). Several factors could account for the positive relationship. First, participation in formal social groups provides individuals with information (Jones, 2010). Information about environmental issues can encourage individuals to participate in public activities, such as separation and recycling of waste.

Moreover, social participation may develop and enforce moral norms regarding environmental protection that may have a positive effect on recycling behaviour. Finally, individuals who actively participate in social groups may have a higher probability of doing recycling because they may have a "warm-glow" feeling for environmental protection.

Linking social capital matters, too. Talking politics and listening to political debates are variables that present a positive and significant association with the number of separate waste collections from at least one material to at least three materials [REC1 – REC3]. A plausible reason for this finding is that individuals who are interested in political issues are better informed and are well-versed in environmental issues (Torgler and García-Valiñas, 2007; Jones et al., 2009). Hence, politically interested people may have a greater willingness to participate in recycling programmes.

Church attendance exhibits a positive and statistically significant correlation, at the 1 percent level, with the number of household separate waste collections. Indeed, religious participation may provide knowledge and information on recycling programmes. Furthermore, religious traditions and religious participation may support moral norms, which may have a positive influence on pro-environmental behaviour such as recycling.

The householder who reads a newspaper every day is more probably to recycle from at least one material to all five (REC1 –REC3) while those who listen to the radio every day are more likely to recycle from one to at least four materials. Newspapers and the radio are potential sources of information about recycling programmes (Nixon and Saphores, 2009).

7. Conclusions

The present study analysed households' waste recycling behaviour, focusing on their efforts linked to multiple separate collections of domestic waste. The main purpose of our work was to provide insights into non-economic factors that drive households' recycling activities. To this end, we examined the relationship between intrinsic incentives, such as peoples' concerns on environmental issues and social capital, and their effort to sort household waste materials to be recycled. Specifically, we identified the following environmental concern variables: *waste production and disposal*; *pollution*; *climate change*; *resource depletion*; and *alteration of environmental heritage*. Based on both theoretical and empirical analysis, we interpret waste production and disposal as egoistic concerns, environmental pollution and climate change as altruistic concerns, resource depletion and alteration of environmental heritage as biospheric concerns. Moreover, we control for three types of social relations: bonding, bridging and linking social capital.

We chose to perform the empirical analysis in Italy by using the Multipurpose Household Survey (MHS) conducted by the National Institute of Statistics (ISTAT) in the year 1998 for two reasons. First, to the best of our knowledge, the empirical assessment of the association between general environmental concerns and households' waste recycling has never been performed in Italy. Second, the survey conducted in the year 1998 helps to point out the effect of peoples' environmental concerns and social relations on their waste recycling behaviour more effectively: at the end of 1990s, in Italy there were neither the institutional constraints obliging the public to make separate waste collection, nor were there monetary incentives that could encourage households to sort the waste produced at source. Thus, peoples' attitudes and behaviour related to waste issues were mainly affected by intrinsic incentives.

Our econometric analysis, which aimed to investigate the relationship between households' waste recycling and general environmental concerns, controlling for socio-economic, policy, and pro-social capital variables, shows the following main results.

First, all variables considered, i.e. *waste production and disposal*, *pollution*, *climate change*, *resource depletion* and *alteration of environmental heritage*, are statistically significant at 1 percent and positively associated to the number of household separate waste collections. These findings highlight that all types of concerns based on the above three value orientations drive householders to take up recycling.

Second, as the number of separate waste collections increases, the magnitude of the marginal effects of egoistic, altruistic and biospheric concern variables decreases. This highlights the relevance of the marginal cost of sorting when the number of separate waste collections increases.

Third, some types of social capital matter for the highest number of separate waste collections. Indeed, bridging social capital (passive and active membership in formal organisations), church attendance and the habit of reading newspapers are always positively correlated with the increasing number of separate waste collections.

Finally, a set of socio-economic variables are correlated with household recycling behaviour: being female, married, aged between 51 and 70, a higher household income, being retired, a homeowner and living in a large home is associated with a greater likelihood of making separate waste collections. On the contrary, being poorly educated, in poor health, unemployed or self-employed is related with less probability of sorting domestic waste at source.

Could these findings also be valid today in Italy? After 20 years of separate waste collections, Italy now has a system of door-to-door separate waste collection, monetary incentives and a separate collection rate of 52.5%. However, the latter is lower than the 65% set by the European Waste Directives (ISPRA, 2017, 2008/98/EC).

Yet after 20 years of separate collection in Italy, further studies would appear necessary to determine whether monetary incentives have played a positive role in increasing the pro-environmental behaviour of households, and whether monetary incentives and door-to-door separate waste collection have "crowded out" environmental concerns and social relations.

The study presents two major limitations. First, our empirical results cannot be generalised since they depend on the dataset adopted, referring to Italy, which is a member of the European Community with its specific cultural, social and economic features. Second, we are unable to test a causal relationship between environmental concerns and household waste recycling behaviour.

Declarations of interest

None.

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Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2019.04.184.

Appendix A

Table A1
Detailed description of variables

Variable	Description
Dependent variables	
At least one recycling	At least one recycling among paper, glass, plastic, aluminium, and food, 1 = yes always
At least two recyclings	At least two recycling among paper, glass, plastic, aluminium, and food, 1 = yes always
At least three recyclings	At least three recycling among paper, glass, plastic, aluminium, and food, 1 = yes always
At least four recyclings	At least four recycling among paper, glass, plastic, aluminium, and food, 1 = yes always
At least five recyclings	All recycling of paper, glass, plastic, aluminium, and food, 1 = yes always
Independent variables	
Key independent variables: environmental concerns	
EC1. Waste production and disposal	0-1 scale: waste production and disposal
EC2. Pollution	0-5 scale: air, oil, water, electromagnetic, noise
EC3. Climate change	0-2 scale: greenhouse effect, climate change
EC4. Resource depletion	0-2 scale: depletion of natural resources, destruction of forests
EC5.Alteration of env. heritage	0-2 scale: species extinction, landscape destruction
Policy variables	
Judgment on waste disposal fee	Household head judgment on the waste disposal service charge, 1 = high
At least one recycling bin	Presence in the area where the household lives of at least one recycling bin, 1 = yes
At least two recycling bins	Presence in the area where the household lives of at least two recycling bins, 1 = yes
At least three recycling bins	Presence in the area where the household lives of at least three recycling bins, 1 = yes
At least four recycling bins	Presence in the area where the household lives of at least four recycling bins, 1 = yes
All five recycling bins	Presence in the area where the household lives of all five recycling bins, 1 = yes
Demographic and socio-economic characteristics	
Male	1 = male. **Reference group: female**
Married	1 = married. **Reference group: single**
Divorced	1 = divorced
Widowed	1 = widowed
Age31-40	1 = age between 31 and 40. **Reference group: age 16–30**
Age41-50	1 = age between 41 and 50
Age51-60	1 = age between 51 and 60
Age61-70	1 = age between 61 and 70
Age71-80	1 = age between 71 and 80
Household size	Number of people who live in family
Children0_5	1 = number of children aged between 0 and 5 years. **Reference group: no children**
Children6_12	1 = number of children aged between 6 and 12 years
Children13_17	1 = number of children aged between 13 and 17 years
Low education	1 = no education, completed elementary school (5 years) and completed junior high school (8 years)
High school (diploma)	1 = completed high school (13 years). **Reference group**
Bachelor's degree	1 = university degree and/or doctorate (18 years and more)
Household income (ln)	Natural logarithm of imputed household income (sum of labour income, capital income and pensions)
Poor health	1 = if the respondent assesses his/her state of perceived health as poor. **Reference group: fair health**
Good health	1 = if the respondent assesses his/her state of perceived health as good
Unemployed	1 = unemployed. **Reference group: employed**
Entrepreneur	1 = entrepreneur
Self-employed	1 = self-employed
Retired	1 = retired
Homeowner	Respondent owns his/her home outright, yes = 1
Council house	Respondent lives in a council house, yes = 1
Rooms	Number of rooms, 1 = between 1 and 5 rooms
Perception of community problems	
Micro-criminality	Respondent has been pickpocketed, yes = 1
No parking problems	Respondent states that there is no difficulty parking in the area where he/she lives, yes = 1
No traffic problems	Respondent states that there is no traffic in the area where he/she lives, yes = 1
No pollution	Respondent states that there is no pollution in the area where he/she lives, yes = 1
No dirtiness problems	Respondent states that there is no filth in the area where he/she lives, yes = 1
City size	
Metropolis	Respondent states that he/she lives in a metropolitan area, yes = 1. **Reference group: < 2000**
Neighbouring metropolis	Respondent states that he/she lives in a municipality close to a metropolitan area, yes = 1
>50,000	Respondent states that he/she lives in a municipality with more than 50,000 inhabitants, yes = 1
10,000–50,000	Respondent states that he/she lives in a municipality with 10,000–50,000 inhabitants, yes = 1
2,000–10,000	Respondent states that he/she lives in a municipality with 2,000–10,000 inhabitants, yes = 1
Social capital variables	
Meeting friends	Meeting with friends, 1 = every day or more than once a week
Visiting relatives	Meeting with relatives, 1 = everyday or more than once a week
Passive membership	Participation in meetings of formal organisations, 1 = voluntary service, ecological, cultural, political party and unions
Active membership	Unpaid activity for formal organisations, 1 = voluntary service, other, political party and unions
Church attendance	Respondent goes to church once or more a week, 1 = yes
Talking politics	Talks politics, 1 = every day or more than once a week
Listening to politics	Respondent listens to political debates, 1 = yes
Newspapers	Respondent reads newspapers every day; 1 = yes
Television	Respondent watches television every day; 1 = yes
Radio	Respondent listens to the radio every day; 1 = yes

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